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Trends of sea surface temperatures and productivity in the Peru upwelling since the mid-twentieth century

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Eastern Boundary coastal upwelling systems (EBUS) are hotspots of marine productivity in the global ocean. Ongoing and future modifications of these systems, potentially linked to global climate changes, have become an issue of increasing importance since they may involve important ecosystem changes and associated strong socioeconomic impacts. We investigated trends in sea surface temperatures (SST) and productivity off Peru, un upwelling system that is unequalled in terms of fish productivity, yielding biomasses one order of magnitude higher than other coastal upwellings. For this, we reconstructed coastal SST based on the alkenone-UK'37 index from laminated sediment records covering the last ca. 150 years and compiled them with available instrumental and satellite-derived data of coastal winds and SST during the recent decades. Sedimentary proxy records of alkenones and total organic carbon, and time series of surface Chlorophyll-a contents were used to infer productivity changes.

SST reconstructions showed a steady cooling for the latter part of the 20th century that is stronger than interdecadal variability during the last 150 years. Instrumental SST data confirm this coastal cooling trend, and ERA 40 reanalysis indicates its link with intensified alongshore winds driving upwelling. Consistently, both proxy and instrumental data evidence increased productivity in phase with the SST cooling, which is assigned to the interplay between stronger upwelling and more rapid thermal stratification when upwelling is relaxed, due to offshore warming.

Our data are consistent with, and expand on recent reports from other EBUSs, off NW Africa (McGregor et al., 2007) and Benguela (Leduc et al., 2010). They thus support current scenarios on the response of these systems to global warming. In the upwelling off Peru, the role of local/global mechanisms, such as enhanced winds due to land-sea thermal gradients or spin-up of the South Pacific High Pressure cell, is not yet fully constrained. Intensification of coastal upwelling will likely have important ongoing/future impacts on the biogeochemical cycling (e.g. air-sea gas fluxes, export production, redox dynamics) and ecosystems that need to be assessed.

McGregor, H. V., M. Dima, H.W. Fischer, and S. Mulitza (2007), Rapid 20th century increase in coastal upwelling off Northwest Africa, Science, 315, 637–639.
Leduc, G., C. Herbert, T. Blanz, P. Martínez, and R. Schneider (2010), Contrasting evolution of Sea Surface Temperature in the Benguela upwelling system under natural and anthropogenic climate forcings. Geophysical Research Letters, 37, L20705, doi:10.1029/2010GL044353.